

CHAPTER

# 16

## Computers and Laboratory Information Systems

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## I. DEFINITIONS

- A. **Data** are raw facts that have no meaning until grouped together or organized.
- B. **Information** is data organized and grouped to increase a user's knowledge.
- C. **A personal computer (PC)**, also referred to as a microcomputer or desktop computer, is a stand-alone computer that contains a central processing unit (CPU), monitor, hard drive, etc., and can be used for processing data.
- D. **An operating system** is a computer program that controls the basic operation of a computer and allows other software to interact with the computer hardware (e.g., Windows Vista, UNIX, and Mac OS).
- E. **A server** is a computer with a large amount of memory and storage capacity that stores data accessed by other computers, called clients or workstations. Programs (applications) can also be stored on servers.
- F. **A mainframe** is a large-capacity computer designed to support many users at once with little or no down time. The term can have different meanings, but today it often refers to computers compatible with the IBM System/360 series of computers.
- G. **Supercomputers** are computers that, at the time of their production, are on the forefront of processing speed. They contain hundreds of CPUs.
- H. **A local area network (LAN)** is a collection of hardware, including printers and PCs, or clients connected to at least one server through cables (hardwired) or via a wireless network. The PCs are able to send data and share files with others on the network.
- I. **An intranet** is a network of computers and other hardware that is not accessible to anyone outside that organization or office.
- J. **A wide area network (WAN)** is a computer network over a large geographic area that crosses metropolitan or national boundaries.
- K. **Computerized provider order entry (CPOE)** is a method of digital entry of instructions for the diagnosis and treatment of patients by a medical practitioner.
- L. **An electronic health record (EHR) or electronic medical record (EMR)** is a digital patient record that can include demographics, test results, medical history and examination, images, etc. EHRs can be accessed via computer over a network.
- M. **A hospital information system (HIS)** is a powerful computer system that includes hardware and software responsible for storing patient, business, and

employee data. An HIS is often linked to other digital information systems (e.g., laboratory information system).

- N. **A community health information network (CHIN)** is a network of computers in a community or city that shares information on patients. Hospitals, reference laboratories, physician offices, pharmacies, health insurance companies, etc. can have access to patient information.
- O. **Malware** is malicious software that can damage computers and includes viruses, Trojans, spyware, etc.
- P. **Informatics** is the science of information, the practice of processing information, and the development of information systems.

## II. GENERAL COMPUTER INFORMATION

### A. Digital Data

1. Computers process and store data with numbers.
2. **Binary (base 2):** Computers use a series of 0's (zeroes) and 1's (ones); 0 is off and 1 is on.
3. **Bit:** A 0 or 1
4. A **Byte** is a series of 8 bits. It takes one byte to represent one character. There are  $2^8$ , or 256, combinations of bytes. Storage capacity is measured in kilobytes (KB), 1024 bytes; megabytes (MB), 1024 kilobytes; or gigabytes (GB), 1024 megabytes.

### B. Computer Hardware

1. The **CPU** contains millions of transistors and performs mathematical and logical operations. The speed of the CPU is measured in **clock speed**, or gigahertz (GHz), which is the number of cycles per second. **Cache memory** is the location of data being processed by the CPU and is located on the CPU. Cache memory is the fastest memory on a computer, but it is also the most expensive. Modern computers have dual or quad processors.
2. **Memory modules** are the location where **random access memory (RAM)** is stored. RAM contains data waiting to be processed or that has recently been processed by the CPU. RAM requires continuous electricity to be maintained; any data in RAM is lost when the computer loses power. Modern computers generally have 2–4 GB of RAM.
3. The **motherboard** is a circuit board connecting the other components of the computer. The CPU, memory modules, and other circuit boards are plugged into the motherboard. When the power is turned on, the motherboard distributes power to the integrated circuits and moves data through the components. The electronic pathway for the movement of data is referred to as the **databus**.

4. **Input devices:** A number of devices can input data into a computer.
  - a. Keyboard
  - b. Pointing device (e.g., mouse and touch-sensitive pad) is used with a **graphical user interface (GUI)**.
  - c. Bar code reader or scanner reads printed bar codes, a series of parallel lines that represent letters or numbers. Bar codes are used to identify patients and patient samples.
5. **Output devices**
  - a. **Monitor**
    - 1) **Resolution** is measured in the number of **pixels (picture elements)** and the **dot pitch**. A pixel is the smallest piece of information in an image. It is composed of three dots: red, green, and blue. A monitor with a resolution of  $1024 \times 768$  has 1024 columns and 768 rows of pixels. Dot pitch refers to the distance between dots of light of the same color. The smaller the dot pitch and the greater the number of pixels, the better is the image.
    - 2) **Liquid crystal display (LCD)** monitors have become the industry standard. They take up less space, are lighter, and use less electricity than the older **cathode ray tube (CRT)** monitors.
  - b. **Printers**
    - 1) **Inkjet printers** spray ink onto paper.
    - 2) **Laser jet printers** use the precision of a laser to position dots on a drum with magnetized toner. The particles are fixed to the paper with heat. Laser jet printers are faster but more expensive to purchase compared to inkjet printers. Generally, however, the cost per page is less for a laser jet printer.
    - 3) **Plotters** are vector graphic printing devices that print line art by moving a pen over the surface of paper. They are used for large technical drawings (architectural) and computer-aided designs.
6. **Storage devices**
  - a. **Hard drives** use magnetized microscopic particles embedded in a surface. Data are added and retrieved using a read/write head. Hard drives can be internal or external. **Disk arrays** are a series of linked, generally external, hard drives with much larger storage capacity. Hard drives allow **random accessing** of data, meaning the computer can directly read or write to any location on the disk.
  - b. **Floppy disks** also use magnetized particles, as do hard drives. Floppy disks are portable, but they have a much smaller storage capacity. They have generally been replaced by other storage devices.
  - c. **Tape drives**, or streamers, read and write data to a magnetic tape. Data are stored **sequentially**, meaning the data can only be accessed in an ordered sequence. They are generally used to back up large amounts of data and typically have a storage capacity of 4–20 GB. Sequential storage is an

- effective use of space, but it takes longer to access the data compared to accessing data on a hard drive.
- d. **USB flash drives** contain a universal serial bus (USB) connector and a flash memory chip (circuit). Because of their compact size, large storage capacity, and ease of use, these storage devices are widely used.
  - e. **Compact discs (CDs) and DVDs (digital versatile discs or digital video discs)** are optical storage devices. Data are stored as either “pits” or “grounds” on the disks in thin closely spaced **tracks**. A laser is used to read the data on the disks. DVDs have tracks that are much closer together and, therefore, they have greater storage capacity.
7. **Cables** are used to connect external components (**peripherals**) to the computer via the motherboard.
- a. **Serial cables** move one bit of data at a time. Serial cables are no longer commonly used; they have been replaced by USB cables.
  - b. **Parallel cables** move one byte of data at a time. Parallel cables had been used to connect printers and laboratory instruments to a computer. Parallel connections have generally been replaced by USB connections, which are much faster and use thinner cables.
  - c. **USB** cables are commonly used to connect peripherals. They allow multiple devices to be connected through a single port; allow plug and play (hot swapping), where a device can be removed without restarting the computer; and provide power to low-consumption devices.
  - d. **IEEE 1394** interface (i.e., Firewire, Apple Inc.) is a high-speed serial connection commonly used to connect digital cameras and audio/visual components to a computer.

### C. Electronic Communication

1. The **Internet** is a worldwide network of computers.
2. **Transmission control protocol (TCP)** is the protocol computers use to exchange data on the Internet. It allows electronic mail (**e-mail**) and the content of Web sites to be sent electronically. TCP divides messages and files into smaller pieces called **segments**.
3. **Internet protocol (IP) address** is a unique address that electronic devices (e.g., computers and printers) use in order to communicate with each other on a computer network.
4. **Bandwidth** refers to the rate data are transferred; it is usually measured in kilobits/second (Kbps).
  - a. A **broadband** connection is one that transfers a lot of **digital data** at once or when multiple pieces of data are sent simultaneously. Computers need a **network interface card (NIC)** to connect to a broadband cable. Examples of cable connections include:
    - 1) **Ethernet cable** (1 gigabit/second)
    - 2) **Coaxial cable** (10 megabits/second)

- 3) **Fiber optic cable** (600 megabits/second)
- b. A **dial-up connection** over a telephone line is a **narrowband connection** (56 Kbps). A **modem** converts the computer's digital signal to **analog**. The computer receiving the data must then use a modem to convert the analog signal back to digital.
5. **Wi-fi**, or “wireless fidelity,” allows wireless access to computer networks via radio waves. Although distances vary, with a standard antenna distance is limited to about 100 feet.
6. The **World Wide Web**, or the Web, is a body of information (documents) interlinked and accessed via the Internet. Sir Tim Berners-Lee is credited with creating the Web in 1989.
  - a. **Hyperlinks**: A navigational element in one document links to another section of the same document or to a different document
  - b. **Hypertext transfer protocol** (HTTP) is a communication protocol for the transfer of information (hypertext) over a computer network.
  - c. **File transfer protocol** (FTP) is a network protocol used for uploading documents to a Web server.
  - d. **Uniform resource locator** (URL) is a string of characters that provides the address or location of a unique document available over the Internet.
  - e. **Hypertext markup language** (HTML) and extensive markup language (XML) are standard languages used for Web pages. Web browsers read the text (i.e., HTML code) and display the information.
7. **Search engines** use **spiders** or **bots** (short for robots) to retrieve information found in Web pages and create a searchable database.
8. **Telemedicine** is the use of technology to send healthcare-related information (e.g., patient test results) for clinical diagnosis and treatment.

### III. LABORATORY INFORMATION SYSTEMS

**A. A laboratory information system (LIS)** is a computer network of hardware and software for receiving, processing, and storing laboratory data and information. It can interface with laboratory instruments to transfer data into patient records, evaluate quality control data, and store preventive maintenance records. In addition, an LIS can interface with an HIS, pathology information system, and other information systems.

#### **B. Components of an LIS**

1. The LIS software **user interface** determines how the user will interact with the system. It will have specific screens for entering data, sending reports, reporting results, etc. The software will have features such as security, access control, file maintenance, etc.



2. **Request entry:** Requests for laboratory tests to be performed can be entered through clients located in the nursing units or remote primary care practitioner's office. In the case of outpatients, requests can be entered when the patient arrives at the laboratory.
3. **Data (results) entry**
  - a. **Electronic data interface (EDI)** connections between an LIS and a clinical instrument allow automatic transfer of patient test results to the LIS.
  - b. **Manual data entry:** Laboratory scientist enters patient results at a client
  - c. **Release patient results:** The results are added to the LIS, but they are not released to clients outside the laboratory until the results and quality control are reviewed and verified. Alternatively, **autoverification** can be used. In this case, the computer uses a set of instructions to determine if the results should be released. Because the results are not held up for manual review, autoverification is quicker. To help with verification, reference ranges and panic values can be programmed into the LIS.
  - d. **Point of care testing:** Portable laboratory instruments, like handheld analyzers, can connect to an LIS via a wireless connection.
4. **Data storage**
  - a. **Redundant arrays of independent disks (RAID):** LISs are regulated by the Food and Drug Administration, and they are required to have **mirrored hard drives**. Data are stored on two separate hard drives of the LIS server.
  - b. **System backup:** Each day the data are to be copied to a tape, or other portable storage device, and removed from the laboratory.
5. **System security:** Ongoing procedures to ensure the security of patient data and user profiles (usernames and passwords) to prevent unauthorized access must be in place. Users should have access only to the patient information and LIS functions needed to perform their job (minimum necessary use). Antiviral software (e.g., McAfee and Norton) should be installed to protect the system from harmful **malware**, especially for networks with a Windows operating system.
6. **Barcoding** can facilitate processing of clinical specimens.
7. **Interface:** The LIS can be connected to clinical instruments and other information systems through an EDI. An interface is typically **bidirectional**, meaning information is sent to and from the instruments and the information systems. With a **unidirectional** interface, analyte results from an instrument are sent to the LIS, but the LIS cannot send requests to the instrument. So that instruments and computers used in healthcare can communicate with each other, the **Health Level 7 (HL7)** communication standard was adopted. HL7 is an international committee formed in 1987 to formulate data standards, a set of rules that allow healthcare information to be shared and processed in a uniform and consistent way.
8. **Manual procedures:** If the computer system goes down, a contingency plan for manual procedures and forms needs to be in place.

9. **System maintenance:** LISs need to be shut down (taken offline) periodically for software upgrades and other maintenance. Occasionally, the system will become nonresponsive (crash).
10. **Disaster recovery:** Every laboratory needs a plan to restore the system after system disruption by a storm, fire, or other hardware damaging situation.

### C. Information Provided by an LIS

1. **Patient demographics**
2. **Work lists**
3. **Data retrieval (inquiry)**
  - a. Generate patient results: Flag critical values, print reports if requested, etc.
  - b. Perform **delta checks:** Results of an analyte assay are compared to the most recent previously performed results on the same patient
  - c. Patient results can be retrieved electronically at a client or via the Internet with a Web browser.
4. **Reflex testing:** If an initial test result is positive or outside normal parameters, the LIS can automatically order a second appropriate test.
5. **Current procedural terminology (CPT) codes:** The CPT codes describe medical, surgical, and diagnostic services and are designed to communicate information about medical services and procedures among physicians and other healthcare professionals. CPT codes are used for billing purposes and can be programmed into the LIS.
6. **Quality control:** An LIS can analyze quality control specimens and prepare charts and reports (e.g., Westgard rules, Levey-Jennings charts).
7. **Quality assurance** can provide reports on turnaround time, documentation of critical result reporting, and corrected reports.
8. **Management reports:** Cost per billable test calculations, test volume, turnaround time, employee hours, workload data, etc.
9. **Encoding systems:** Systemized Nomenclature of Medicine—Clinical Terms (SNOMED—CT) is a comprehensive database of standardized terminology for healthcare. Once implemented, it will allow automatic data analysis over a wide range of clinical information systems. Logical observation identifiers names and codes (LOINC) is another database of universal standards for healthcare.

### D. Selecting an LIS

1. The process begins with a laboratory **needs assessment**, where data are collected on the information needs of the laboratory.
2. **Needs are analyzed** to determine feasibility of a system and what is needed to get the job done.
3. Laboratory managers and administrators form a committee and prepare a **request for proposal** (RFP). The RFP contains information about the laboratory facility, lists specific requirements needed in an LIS, and poses questions about LISs. This information may include interface capabilities to



- hospital information systems and laboratory instruments, remote user access, system requirements, custom features, hardware and software maintenance contracts, etc. The RFP is distributed to vendors.
4. Vendors will respond to the RFP describing how their systems will meet the needs of the laboratory and the estimated cost of the systems.
  5. The RFP responses will be reviewed by the committee. To prevent information overload and confusion, only a few of the vendors, those that submitted an RFP response that match the needs assessment, should be selected to give demonstrations.
  6. **Vendor demonstrations and visits to other laboratories** using the systems help narrow the choices. Vendor demonstrations should be scheduled within a short time frame so that information is fresh in everyone's mind.
  7. **Selection** is based on the system that can best meet the laboratory's needs at the lowest cost (i.e., the cost does not outweigh the benefit).

#### E. Installation

1. The installation process is important and very time-consuming. It is critical to identify any errors early in the process before the system is activated (**goes live**).
2. Vendor representatives will install the server, clients, network connections, and software.
3. **Testing:** A thorough test of individual components (**unit test**) and a test of the system (**integration test**) are performed.
4. **Training** laboratory personnel and other healthcare providers on the LIS is an expensive process. It is important to discuss this with the vendor before accepting a proposal. Management needs to know how many people the vendor will train. It will become the responsibility of the laboratory personnel receiving training to train others. Training will also be needed for healthcare providers outside the laboratory.
5. **Communication:** Before the LIS goes live, it is important to communicate to all members of the healthcare team about the planning and timeline of the process.

#### F. System Validation

1. Validation of the laboratory information system is an ongoing process of proving the system performs its intended use initially and over time.
2. Validation consists of defining, collecting, maintaining, and reviewing evidence that the system is performing consistently according to specification. It is tedious, difficult, and costly, but it must be done to assure that the system meets the needs of the laboratory.



review

questions

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**INSTRUCTIONS**

Each of the questions or incomplete statements that follows is comprised of four suggested responses. Select the *best* answer or completion statement in each case.

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1. You have been asked to chair a committee to recommend the purchase of a laboratory information system. What is the first step you should take?
  - A. Issue a request for proposal
  - B. Develop a needs assessment
  - C. Contact vendors for product demonstrations
  - D. Determine the encoding system that will be used
2. A computer's central processing unit (CPU) is regulated by clock speed, which is measured in gigahertz. What is the clock speed?
  - A. Number of intervals or cycles per second
  - B. Memory storage capacity on the microprocessor
  - C. Amount of data that can be moved between the CPU and the motherboard
  - D. Communication speed between the microprocessor and the motherboard
3. An electronic data interface is used to
  - A. Access the Internet
  - B. Connect instruments to a laboratory information system
  - C. Manually enter patient results into a laboratory information system
  - D. Provide security to patient records
4. The fastest type of memory a computer has access to is
  - A. Random access
  - B. Sequential
  - C. Serial
  - D. Cache
5. In the event that electrical power to a computer is interrupted, all data or information in the random access memory (RAM) would be
  - A. Lost
  - B. Located on the hard drive
  - C. Conserved or lost, depending on the length of the interruption
  - D. Conserved or lost, depending on the electronic activity at the time of interruption

6. In networked computer systems, what does the term “client” refer to?
  - A. Manufacturer of the software
  - B. Software that allows the connected hardware to communicate
  - C. Computer that provides software to user terminals
  - D. Workstation from which the user requests services from the server
7. A worldwide network of computers describes
  - A. Hyperlinks
  - B. Hypertext markup language
  - C. Search engines
  - D. The Internet
8. When comparing monitors, it is important to consider the dot pitch. What is dot pitch?
  - A. Angle of the screen
  - B. Distance between light dots
  - C. Total number of pixels on the screen
  - D. Number of different colors the monitor can display
9. Which of the following is an example of an optical storage device?
  - A. Compact disk
  - B. Flash (thumb) drive
  - C. Floppy disk
  - D. Hard drive
10. Computers process and store data using a binary system. This is equivalent to
  - A. Base 2
  - B. Base 4
  - C. Base 8
  - D. Base 10
11. Which one of the following may be used as a pointing device with a graphical user interface?
  - A. Databus
  - B. Internet connection
  - C. Keyboard
  - D. Mouse
12. Disk arrays are
  - A. High-performance printers
  - B. Large-capacity storage devices
  - C. Broadband Internet connections
  - D. Methods used to search a database
13. Which of the following is considered a narrowband connection?
  - A. Coaxial cable
  - B. Ethernet cable
  - C. Fiber optic cable
  - D. Telephone cable
14. Which of the following is *not* an important part of laboratory information systems?
  - A. Specimen tracking
  - B. Data retrieval
  - C. Transportation
  - D. Order entry
15. USB drives have a universal serial bus connector and a
  - A. Disk drive
  - B. Flash memory chip
  - C. Parallel connection
  - D. Tape drive
16. When architects print large-scale blueprints, what would be the best printer to use?
  - A. Dot matrix
  - B. Inkjet
  - C. Laser jet
  - D. Plotter
17. The speed of Internet access is partly determined by the carrying capacity of the communication line. What is this called?
  - A. Bandwidth
  - B. Interface
  - C. Internet protocol
  - D. Uniform resource locator

18. Many laboratory information systems allow users the option to define actions in response to certain patient results, such as performing additional tests or sending test results to public health authorities. What is this feature called?
  - A. Flagging
  - B. Hot key inquiry
  - C. Host query
  - D. Reflexing
19. Communication among laboratory information systems in different hospitals is becoming more common. Data transfers can be facilitated if laboratories use which standardized communication interface?
  - A. Health level 7
  - B. RS-232C
  - C. Hypertext transfer protocol
  - D. UNIX
20. Search engines use computer programs to collect information found in Web pages. These programs are commonly called
  - A. Hyperlinks
  - B. Spiders
  - C. Malware
  - D. Trojans
21. When documents are uploaded to Web servers, special software is used. This software uses a standard protocol called
  - A. File transfer protocol (FTP)
  - B. Hypertext markup language (HTML)
  - C. Hypertext transfer protocol (HTTP)
  - D. Uniform resource locator (URL)
22. After a hospital has decided to purchase a laboratory information system, what do laboratory administrators issue to solicit bids from vendors?
  - A. Ancillary report
  - B. Good manufacturing practice request
  - C. Request for proposal
  - D. Needs analysis
23. What feature of a laboratory information system compares a patient's test value to a previous value?
  - A. Archiving
  - B. Delta check
  - C. Prompt
  - D. System validation
24. Of the following hardware, which one is an input device?
  - A. Keyboard
  - B. Monitor
  - C. Printer
  - D. Motherboard
25. A networked computer's unique address is called the
  - A. FTP address
  - B. CHIN address
  - C. IP address
  - D. URL



# answers & rationales

1.

**B.** The first step in recommending a laboratory information system is determining the informational needs of the laboratory. Needs are analyzed to determine the feasibility of a system and what is needed to get the job done. Once the needs assessment is complete, a request for proposal (RFP) is announced. Vendors will read the RFP and submit a proposal to the laboratory.

2.

**A.** A computer's clock speed is the number of intervals or cycles per second. Older computers performed one operation per second. Newer microprocessing chips, since the Pentium, can execute more than one instruction per cycle by a process known as superscalar architecture.

3.

**B.** An electronic data interface connects a laboratory information system (LIS) to clinical instruments. The connection allows data (test results) from the instrument to be automatically added to the LIS. This method of entering results is much faster and more accurate than manual entry.

4.

**D.** Cache memory is located on the central processing unit and is the fastest memory to which the computer has access. It is also the most expensive type of memory. Increasing cache memory does, however, reach a point of diminishing returns—after a certain point, the addition of more cache memory does not increase computer performance.

5.

**A.** When a computer loses power, either accidentally or intentionally by turning it off, anything stored in random access memory (RAM) will be lost or erased. In contrast, everything in the read-only memory (ROM) remains at all times. Both the length of interruption and the electronic activity in which the computer is involved at the time of power interruption are irrelevant. Any power interruption to the computer causes all data in RAM to be erased.

6.

**D.** The client is the workstation or terminal requesting data from the server. In other words, the server provides information to the client or user. The client can be a stand-alone desktop computer or a thin client that is only a terminal (monitor and keyboard).

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7.

**D.** The Internet is simply a global collection of computers. The computers providing the information are called servers. Each computer on the Internet has a unique address or location.

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8.

**B.** Pixels are the smallest picture elements that a monitor can control. Pixels contain dots of three different colors: red, green, and blue. Dot pitch, measured in millimeters, is the distance between light dots. The smaller the dot pitch, the sharper is the image. A dot pitch of 0.25 mm is standard.

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9.

**A.** From the list, only a CD (compact disk) is an optical storage device. The data on the CD are read using a laser. Floppy disks and hard drives are magnetic storage devices. A flash drive uses a circuit to store data.

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10.

**A.** Computers function on two states: off or on. Data are stored as a series of zeroes and ones. This is equivalent to a base 2 or binary system.

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11.

**D.** Pointer devices control the movement of a movable icon, usually an arrow, on the monitor. A mouse is the most common type of pointing device. Touch-sensitive pads are pointing devices commonly found on notebook computers.

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12.

**B.** Disk arrays are a series of hard drives used for storing digital data. Because mainframe computers need to store a lot of information, they often have disk arrays. Disk arrays can be internal or external.

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13.

**D.** Because telephone cables or lines (dial-up connection) transmit small amounts of data at

one time, they are considered narrowband. A dial-up connection requires modems to convert data from digital to analog and back again. Coaxial, Ethernet, and fiber optic cables are all digital broadband connections.

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14.

**C.** Laboratory information systems (LISs) can increase the efficiency of clinical laboratories by allowing for specimen tracking, data (e.g., patient results) retrieval, and order entry. The LIS does not transport specimens; a robotics system would be necessary to handle this function. Features of LISs vary considerably among the different vendors and can be customized to the needs of individual laboratories.

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15.

**B.** USB drives store data on a flash memory chip (circuit). These storage devices are small, easy to use, and have a high storage capacity. These features have made flash memory drives very popular.

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16.

**D.** Plotters print by moving a pen over the paper. The paper is stored on a large roll, allowing almost unlimited printing size. Inkjet and laser jet printers can only print on sheets of paper. Dot matrix printers, rarely used today, had a continuous paper feed, but the paper was typically only 8.5 inches wide.

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17.

**A.** Bandwidth is measured in bits per second (bps). It is the amount of information that can be transmitted through a channel or communication line at one time. Internet protocols (IPs) are the standards allowing computers to exchange data via the Internet. Uniform resource locators (URLs) are the addresses used to find Web sites.



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18.

**D.** Most LISs allow users to program additional operations to be performed based on specified patient results. If a patient result for a particular test falls within certain parameters, an additional test may be suggested. These reflexes should automatically include billing codes. Flagging is simply marking high or low critical (panic) values. Hot key inquiries are keys on the computer keyboard programmed to provide the user with additional information, such as reference ranges during data entry. A host query is a type of bidirectional interface between an instrument and the LIS.

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19.

**A.** Hospitals, health maintenance organizations, and physician offices in an area may want to share patient information. In order for the computer information systems to communicate with each other and to exchange data, they must use a standardized transfer protocol. The most widely used interface for this purpose is Health Level 7 (HL7). The RS-232C is a type of serial interface with 25 pins. Hypertext transfer protocol (HTTP) is the protocol followed for the exchange of information on the Web. UNIX is a text-based operating system for servers.

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20.

**B.** Spiders are used by Internet search engines to collect information found on Web pages. Malware refers to malicious software that can damage a computer or steal a user's identity. Trojans are an example of malware.

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21.

**A.** In order for computer files to be accurately transferred on the Internet, standard protocols must be used. The protocols for uploading documents to a Web server are called file transfer protocols (FTPs). Hypertext markup language (HTML) is the language used to create Web pages. Hypertext transfer protocol (HTTP) is the protocol

followed for the exchange of information on the Worldwide Web, and a uniform resource locator (URL) is a unique address for a Web page.

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22.

**C.** In order to get the best price and solutions to a laboratory's computer needs, a request for proposal (RFP) is issued. The laboratory's needs are described, and companies submit proposals describing how the needs would be addressed and what the cost would be. Good manufacturing practice is a regulation issued by the Food and Drug Administration. Laboratories would do a needs analysis to help write an RFP.

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23.

**B.** An LIS can be programmed to compare a patient's test value to a previous value for the same assay. This is called a delta check. A prompt is the user interface of a text-based operating system such as DOS or UNIX. System validation is a tool within the LIS allowing the user to set up and monitor testing, regulatory compliance, and quality control. Archiving refers to storing patient data that are no longer needed onto a backup system to free storage space on the LIS.

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24.

**A.** Input devices are those that send data to the computer. The keyboard is an input device. The monitor displays information (output); however, touch screen monitors can be an input device. Printers are also output devices.

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25.

**C.** A computer's unique address is called the Internet protocol (IP) address. A uniform resource locator (URL) is a unique address for a Web page. A community health network (CHIN) is a computer network in a community that shares data on patients.

## REFERENCES

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